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OBSERVATIONS UPON GALEOPITHECUS VOLANS.

BY HENRY C. CHAPMAN, M.D.

Scattered through the works of Cuvier, Meckel, Owen, Schreber, Wagner, Huxley, and other anatomists, are to be found here and there more or less brief notices upon the anatomy of *Galeopithecus*. So far, however, as known to the author, the only account of this interesting animal approaching the character of a monograph is the admirable work of Leche,¹ which leaves subsequent anatomists but little more to do than confirm, or at best extend, his observations.

The opportunity having been recently afforded the author of acquiring a specimen of *Galeopithecus*, it is hoped, in view of the scant literature of the subject and the conflicting opinions still held by zoologists as to the nature of this animal, that the results of its dissection as well as some reflections upon its natural affinities may prove acceptable.

The specimen, a male measuring 6.4 cent. (16 inches) from the snout to the root of the tail, was obtained from Sarawak, in the Baram district, Borneo. The specimen had been preserved in spirit for a long time, but unfortunately was not in a sufficiently good state of preservation to admit of thorough dissection. It is hoped, however, that the disposition of the parts was sufficiently made out to permit of comparison with the results obtained by Leche and other anatomists. The author has also had the opportunity more recently of examining the viscera of a male *Galeopithecus* obtained in Sumatra by the distinguished travelers, Mr. Alfred C. Harrison, Jr., and Dr. H. N. Hiller, and presented by them to the Academy, which did not differ essentially, however, from those of the Borneo specimen.

SKELETON.

As the skeleton of *Galeopithecus* has often been described, attention will be directed only to those peculiarities which serve to show its

¹ *Ueber die Säugethiergattung Galeopithecus*, Kongliga Svenska Vetenskaps-Akademiens Handlingar, 1884-1885.

relation to the other forms of mammalian life with which it has been affiliated, and the same plan will be pursued in the account of the remaining organs.

Among such peculiarities, as regards the skull, may be mentioned the presence in *Galeopithecus* of the foramen transmitting the supra-orbital nerve and artery, the division of the lachrymal bone into facial and orbital portions, and the interorbital situation of the lachrymal canal. In these respects *Galeopithecus* agrees closely with the insectivorous *Tupaia*. On the other hand, in the formation of the tympanic bulla and in the condyle of the jaw being situated at nearly the same level as the teeth, *Galeopithecus* agrees with bats, *Chiromys*, as well as certain insectivores. In regard to the vertebral column, *Galeopithecus* differs from both Insectivora and Chiroptera in the presence of spinous processes and a pubic symphysis, and in the absence of a ridge on the sacrum and a keel on the sternum. It is an interesting fact that the sacrum, according to Leche,² develops caudad—that is to say, ossifies at the expense of the tail, the reverse of which obtains in other mammals. In the presence of an epicoracoid cartilage lying between the clavicle and first rib, and in the epicoracoid element being united with the clavicle, and in the elongated character of the scapula, *Galeopithecus* and *Pteropus* agree. In the splitting of the coracoid into two distinct processes, dorsal and ventral, the latter the homologue of the coracoid in other mammals, *Galeopithecus* presents, however, a peculiarity not found in lemurs, insectivores or bats, except in *Pipestrellus*, in which bat the coracoid, according to Flower,³ is sometimes forked. It is worthy of mention that in both *Galeopithecus* and *Pteropus* the humerus and radius are of the same length in the young animal, the radius becoming the larger of the two bones only as development advances.

PATAGIUM AND MUSCULAR SYSTEM.

One of the most striking features in the organization of *Galeopithecus* is its patagium, or the duplicature of the skin that extends from the upper extremity to the head (propatagium), from the trunk to both extremities (palatopatagium), and from the lower extremity to the tail (uropatagium), covering the whole animal

² *Op. cit.*, p. 9.

³ *Osteology of the Mammalia*, 1870, p. 227.

like a cloak. While asleep, which is usually diurnal, *Galeopithecus*, so enveloped, hangs head downward, suspended by its hind claws from the branches of a tree, and in that position strikingly resembles *Pteropus* when in the same condition. The patagium of *Galeopithecus* is not a mere cutaneous expansion or parachute which serves to break the fall when the animal descends from higher to lower levels, but being supplied with muscles and nerves it enables the animal (to some extent at least) to fly and to guide itself. That most competent observer, Wallace, writes: "Once, in a bright twilight, I saw one of these animals run up a trunk in a rather open place, and then glide obliquely through the air to another tree, on which it alighted near its base, and immediately began to ascend. I paced the distance from the one tree to the other, and found it to be seventy yards; and the amount of descent I estimated at not more than thirty-five or forty feet, or less than one in five."⁴

While *Propithecus* among lemurs, *Petaurus* among marsupials, and *Pteromys* and *Anomalurus* among rodents, are also provided with a patagium, the latter differs in all these animals from that of *Galeopithecus* in being much less developed, supplied with a different set of muscles and nerves, and is more hairy. The patagium of the above-mentioned animals is therefore not homologous with that of *Galeopithecus*, but rather analogous. On the other hand, the patagium of the Chiroptera in being as extensively developed and supplied by the same muscles and nerves is homologous with that of *Galeopithecus*, even though the calcar or elongated bone or cartilage attached to the inner side of the ankle-joint, which supports the patagium in the Chiroptera, is absent in *Galeopithecus*.

While the scope of this communication does not admit of a detailed account of the muscles and nerves of the patagium of *Galeopithecus* and allied forms, the following may be cited as illustrations, among others, of how closely the patagium of *Galeopithecus* resembles that of bats and differs from that of marsupials, lemurs and rodents. It has been shown by Leche⁵ that while the disposition and nerve supply of the *Platysma myoides* is the same in *Galeopithecus* and Chiroptera, in *Pteromys* the muscle is absent. Further, it appears that the occipito-pollicaris or the muscle extending in Chiroptera from the occipital bone to the termi-

⁴ *Malay Archipelago*, 1869, p. 145.

⁵ *Op. cit.*, pp. 14-18.

nal phalanx of the pollex,⁶ and the jugalis propatagii extending in *Galeopithecus* from the external auditory meatus and malar bone to the finger and palatopatagium are homologous and are supplied by the same nerve, the facial. The coraco and humero-cutaneous muscles, among others, agree essentially in their disposition in *Galeopithecus* and Chiroptera. Further, the striking fold in the palatopatagium of *Galeopithecus*, extending to the ventral surface of the elbow, is an equally characteristic feature in the patagium of the Chiroptera. It was absent, however, in the two specimens of *Pteropus frugivorus* dissected by the author. It should be mentioned, however, that in the uropatagium of the Chiroptera muscles are present that are absent in that of *Galeopithecus*, such as the cutaneo, pubic, ischio and femoro-cutaneous. On the other hand, in *Petaurus*, the muscular fibres of the patagium are so little differentiated that they cannot be homologized with those of *Galeopithecus* or Chiroptera, while in *Pteromys* muscles are present in its patagium that have no homology in *Galeopithecus* or Chiroptera.⁷

Such being the relation of the patagium of lemurs, marsupials and rodents to that of *Galeopithecus* and bats, it is readily conceivable how, on the theory of descent, the patagium of *Pteropus* might be derived from that of *Galeopithecus* by the simple extension of the upper extremity, supposing that such extension was of advantage in the struggle for life, and that the variation, however acquired, was intensified in successive generations. While it does not necessarily follow that because two animals found in the same part of the world and provided with the same kind of patagium and having similar habits should be genetically related, it seems more probable that *Pteropus*, the more specialized animal, should have descended from *Galeopithecus*, the more generalized one, than that the two animals should have acquired such characteristic structures and habits independently of each other.

In regard to the muscles of the head and neck, it may be mentioned that the part of the trapezius arising from the head and neck in lemurs and insectivores is absent in *Galeopithecus* and bats. The insertion of the teres major is quite distinct from that of the latissimus dorsi in *Galeopithecus* and Chiroptera, the action of the former muscle being to reinforce that of the subscapu-

⁶ Macalister, *Myology of the Chiroptera*, Phil. Trans., 1872, p. 128.

⁷ Macalister, *op. cit.*, pp. 14-21.

laris which is very large. The flexor sublimus digitorum and palmaris longus act together in *Galeopithecus* and Chiroptera, as is also the case in the hedgehog. The phalanges supporting the claws in *Galeopithecus* are supplied by the extensor digitorum communis and extensor pollicis longus, the middle and first phalanges by the extensor digiti secundus, indicis, and pollicis brevis. The origin of the psoas major is shorter in *Galeopithecus* and *Pteropus* than in insectivores and lemurs. The disposition of the tensor fasciæ latae, glutæus maximus, and femoro-coccygus muscles are the same in *Galeopithecus*, Chiroptera and *Chryschloris* among the Insectivora. The sartorius, though present in *Galeopithecus*, *Tupaia* and lemurs, is absent in Chiroptera, and the gracilis, while double in *Galeopithecus* and some Insectivora, is single in Chiroptera. The biceps is rudimentary in *Galeopithecus* and absent altogether in Chiroptera. The soleus and plantaris are absent in *Galeopithecus* and Chiroptera, though both these muscles are present in Lemuroidea. The plantaris is, however, absent in *Tupaia*. An extensor brevis digiti quinti appears to be present in *Galeopithecus*, as is also the case in the Chiroptera, and *Loris gracilis* among the Lemuroidea.

NERVOUS SYSTEM.

The brain of *Galeopithecus* having been described and figured by Gervais⁸ and Leche,⁹ the author has but little to add to their descriptions. The most striking feature externally in the brain of the specimen examined by the author, as also noticed by the observers just mentioned, is the almost complete absence of the occipital and temporal lobes, they being so little developed that only the anterior part of the nates are covered by the hemispheres. The olfactory lobes are well developed, and but slightly covered by the cerebral hemispheres; their slender tracts expand posteriorly into the hippocampal uncinated gyrus. On the lateral surface of the brain the hippocampal gyrus is separated from the rest of the brain by a deep sulcus, from the anterior end of which proceeds upward a fissure, the so-called principal fissure (Pansch). The dorsal surface of the brain is furrowed by two parallel sulci, the external one very deep, corresponding, probably, to the interparietal sulcus, the internal much more superficial.

⁸ *Journal de Zoologie*, T. 1, 1872, p. 445, Pl. 31, fig. 5.

⁹ *Op. cit.*, p. 48, fig. 29-32.

On the mesial surface a well-marked calloso-marginal sulcus is present, which comes to the surface and furrows the hemisphere as the cross sulcus between its anterior and middle thirds. A small corpus callosum with its genu, the septum lucidum and fornix, a ventricle containing a thalamus opticus and corpus striatum, an anterior and middle commissure were present, the latter being very much developed. The nates are larger than the testes. The pons varolii is small. The vermis is large, but little separated from the lateral lobes. The flocculi are large and lodged in fossæ of the periotic bones. The brain of *Galeopithecus* differs from that of all other mammals in its hemispheres being so small, and yet at the same time being so deeply furrowed. In comparison with that of affiliated animals, the brain of *Galeopithecus* is less developed than that of lemurs, but more so than that of insectivores. There are, for example, sulci present in the brain of the lemurs that are entirely absent in that of *Galeopithecus* and *vice versa*. The corpus callosum is much more developed in the brain of the former than in that of the latter. On the other hand, the number and depth of the sulci in the brain of *Galeopithecus* are far greater than in the brain of any insectivore. Indeed, sulci are absent in even large insectivorous brains like those of *Tupaia*, *Rhyncocyon*, while the corpora quadrigemina are uncovered in the latter. Of the mammals with which *Galeopithecus* has been affiliated it resembles, as regard cerebral characters at least, the Chiroptera most, the number and disposition of the sulci being the same in the brain of the latter as in that of *Galeopithecus*, though not so deep. On the other hand, the olfactory lobes and corpora quadrigemina are completely covered by the hemispheres in the brain of *Pteropus*, for example, and the corpus callosum is much more developed than in the brain of *Galeopithecus*. The brain of *Galeopithecus* is neither that of a lemur, insectivore nor bat, resembling, however, that of the latter more closely than that of either the other two, standing, indeed, somewhat midway between the Insectivora on the one hand and Chiroptera on the other.

The distribution of the nerves having been thoroughly described by Leche,¹⁰ the author will not dwell upon this part of the economy, but will merely call attention to one or two points of special interest. The facial and third cervical nerves supply the muscles of the

¹⁰ *Op. cit.*, pp. 52-55.

propatagium; the spinal accessory supplies the sterno cleido mastoid, levator claviculæ and trapezius muscles; the axillary branch of the brachial plexus, muscular fibres of the plagiopatagium; the internal cutaneous nerve, the humero and coraco-cutaneous muscles; a branch of the brachial plexus gives off at the distal insertion of the latissimus dorsi muscle the radial nerve, and below divides into the median and ulnar nerves. The median nerve perforates the supracondyloid foramen and supplies thumb, index, middle and inner side of ring finger; the ulnar nerve, the outer side of the ring and little fingers and the muscular fibres of the plagiopatagium. The lumbo sacral plexus is situated nearer the tail than in most mammals, the last lumbar nerve supplying the obturator cruralis and ischiadus muscles instead of the nerve emerging in front of the last two lumbar vertebræ as is usual. The cruralis nerve supplies the plagiopatagium; the ischiadic supplies the uropatagium.

ALIMENTARY CANAL, ETC.

The palatal gum is ridged, as in the lemurs. Parotid and submaxillary glands were present, but so small as to readily escape notice. The ducts are, however, proportionally large; that of the parotid gland crossed the masseter muscle and was more than 25 mm. (1 inch) long; that of the submaxillary gland opened into the mouth far forward, and was almost as long as the duct of sterno.

The teeth of *Galeopithecus* have been described by Owen,¹¹ De Blainville,¹² and others, and the relation of the deciduous to the permanent teeth more particularly by Leche.¹³ One of the most interesting facts established by the latter observer is that the teeth erupt late, so that the deciduous teeth and all the molar teeth (except, perhaps, the upper third) are in use at the same time. The most remarkable feature, however, in the dentition of *Galeopithecus* is the well-known comb-like form presented by the crown of the first two incisors of the lower jaw, due to the deep extension of the marginal notches upon the crown, and in respect to the extent to which this furrowing of the crown is carried unique in mammals.

¹¹ *Odontography*, 1840-1845, p. 433.

¹² *Ostéographie*, 1841, p. 42.

¹³ *Op. cit.*, pp. 56-61.

Each of these broad comb-like teeth is implanted by a single conical fang excavated by a pulp cavity which divides into as many canals as there are divisions of the crown, each canal passing up the latter to its extremity. What particular purpose these comblike incisors subserve in *Galeopithecus* is difficult even to imagine. It is very unlikely that, as has been suggested, the animal uses them to clean its skin. It is far more probable that the peculiar form of these teeth depend in some way upon the nature of the food, which consists of leaves, remains of the latter being found between the teeth, on the tongue and in the œsophagus, and that they have been gradually developed from the tooth of some ancestor in which a slight furrowing of the crown existed and which, being of advantage, was gradually intensified in its posterity. In support of such a view it may be mentioned that there is a slight indication of furrowing of the crown in the incisors of the lower jaw in *Hyrax*, *Indri*, *Tupaia*, *Rhyncocyon*, *Desmodus* and *Diphylla* among Chiroptera. Another interesting peculiarity in regard to the dentition of *Galeopithecus* is the fact of the outer incisor of the upper jaw having two roots, which is also the case not unfrequently in *Pterodromus* and in certain species of *Erinaceus*. The canine of the upper jaw in *Galeopithecus* are likewise provided with two roots, as was the case in the extinct Jurassic mammals, *Pantotheria*,¹⁴ another illustration of the affiliation of *Galeopithecus* with extinct mammalian forms.

The tongue is dented at the end, the dents supporting round papillæ. This pectinated condition of the end of the tongue may possibly be correlated in some way with that of the lower incisor teeth. The under surface of the tongue is deeply grooved. Two large circumvallate papellæ and foliate papillæ at the sides of the tongue are also present. There is only a slight indication of the under tongue, so prominent a feature in lemurs, which is present also in *Tupaia*, but entirely absent in Chiroptera.

The stomach (Plate XII) is very much elongated and drawn out, resembling that of *Pteropus*. The mucous membrane of the cardiac part is smooth. That of the pyloric part lying toward the cardia is thrown into deep folds, which run parallel with the long axis of the stomach, while the remaining part of the pyloric mucous membrane is smooth again. The small intestine preserves about the

¹⁴ Marsh, *Amer. Journal Arts and Sciences*, Vol. 20, p. 239, 1880.

same diameter throughout its whole extent. Villi are present and there is an ileo cæcal valve. A tapeworm was found in the small intestine, but in such a disorganized condition as not to admit of identification. The cæcum is long and capacious and puckered up, the muscular fibres being gathered together into three well-marked wide bands. A long and capacious cæcum is found as well known in lemurs, and though less well developed in certain insectivores as *Macroscelides* and *Rhyncocyon*. A cæcum is also present in some species of *Tupaia* and absent in others. While usually absent in Chiroptera, it is nevertheless found in a rudimentary condition in certain species of *Rhinopoma* and *Megaderma*. The cæcum of *Galeopithecus* agrees with that of the lemur more than with that of either Insectivora or Chiroptera in being constricted into pockets or cells. The large intestine, larger than the small one as obtains in certain Herbivora, may be divided somewhat arbitrarily into three parts, distinguished by the disposition of the muscular fibres and the character of the mucous membrane, the first part consisting of about one-seventh, the second of two-sevenths, and the third part of four-sevenths of the entire length of the gut. Peyer's patches are found throughout the long intestine, as is also the case in Edentata, Rodentia and Insectivora. The length of the alimentary canal (including the oesophagus) and parts of the same appear to vary considerably as shown by the following *résumé*, the difference being due possibly to the age of the animal examined:

	Leche ¹⁵ specimen.		Borneo specimen.		Sumatra specimen.		Owen ¹⁶ specimen.	
	mm.	in.	mm.	in.	mm.	in.	mm.	in.
Length of animal	400 = 16		375 = 15		350 = 14		400 = 16	
Length of stomach	58 = 2.3		100 = 4		75 = 3			
S. int.	450 = 18		650 = 26		550 = 22		1,300 = 52	
L. int.	470 = 18.8		1,000 = 40		800 = 32		2,275 = 91	
Cæcum	74 = 2.8		225 = 9		175 = 7		25 = 1	
Ratio of length of animal to length of alimentary canal .	1 to 2.9		1 to 5.5		1 to 4.8		1 to 9.2	

According to Cuvier,¹⁷ the length of the alimentary canal is about three times the length of the animal. This estimate agrees more closely with the results obtained by Leche and the author than those of Huxley,¹⁸ who states that the alimentary canal is six

¹⁵ *Op. cit.*, p. 63.

¹⁶ *Anat. of Vertebrates*, 1868, Vol. III, p. 430.

¹⁷ *Anatomie Comparée*, 2d Ed., 1835, Tome 4, 2d Partie, p. 185.

¹⁸ *Anatomy of Vertebrated Animals*, 1872, p. 383.

times the length of the animal, which is not the case in any of the first three animals examined. The total length of the alimentary canal in Owen's specimen, not counting the œsophagus and stomach, exceeds so much that of the other three as to give the impression that possibly Owen's figures are erroneous, due, possibly, to a typographical error or otherwise. The difference in the length of the cæcum in the four specimens is very noticeable, that of Leche's specimen being nearly three times as long as that of Owen's, and those of the Sumatra and Borneo specimens seven and nine times as long respectively. The capacity of the cæcum has been stated as being equal to that of the stomach. While such was no doubt the case in Leche's specimen, in both the Sumatra and Borneo specimens the capacity of the cæcum was greater than that of the stomach. In the case of two lemurs recently dissected by the author, with the view of comparing the structure of the lemur with that of *Galeopithecus*, in one, *Lemur albifrons*, measuring from the snout to the root of the tail 38.7 cent. (15.5 in.), the cæcum measured 17.5 mm. (7 in.) and in the other, *Loris tardigradus*, 37.5 cent. (15 in.) long, the cæcum measured 5 cent. (2 in.). The liver is divided into two halves, the right half being the largest, and subdivided into three lobes. The gall-bladder is small and elongated. The ductus choledochus enters the small intestine 50 mm. (2 in.) from the pyloric orifice. The pancreas lying in the mesentery is flattened and much branched. Its duct enters the intestine 20 mm. ($\frac{4}{5}$ in.) from the orifice of the choledochus. The spleen attached to the cardiac part of the stomach by the gastro-splenic ligament is triangular in form and presents at the anterior part of its median surface a small but well-defined process.

RESPIRATORY AND CIRCULATORY ORGANS.

PLATE X.

The posterior nares are narrow. The larynx does not present anything of especial interest. The trachea was 100 mm. (4 in.) long, and its rings were complete. The lungs are undivided; the right lung is slightly larger than the left. There are three vena cavæ, two superior and one inferior. The left superior cava passing behind the heart to empty into the right auricle. A similar disposition obtains also in certain Insectivora and Chiroptera, but not in Lemuroidea there being but one superior vena cava in

the latter. There are three arteries given off from the arch of the aorta, a left subclavian, left carotid and an innominate, the latter dividing into right carotid and right subclavian, the disposition of the great blood vessels being the same, therefore, as in man. In lemurs, the innominate gives off the right subclavian and both carotids; in the hedgehog among the insectivores the arch of the aorta gives off two vessels, each of which subdivides into subclavian and carotid, while in the bats the vessel subdividing into the two carotids arises from the arch separately from the subclavians.

GENITO-URINARY ORGANS.

PLATE XI.

The right kidney lies higher, that is nearer head than the left; only one Malpighian pyramid is present. There was nothing exceptional in the ureters and bladder. The scrotum is well developed and contained the testicle and epididymis. There was nothing peculiar about the vas deferentia. The spermatic vesicles, perfectly distinct, were large, extending beyond the base of the bladder. The prostate gland was also much developed, and embraced the dorsal surface of the urethra. The Cowper's glands were also large. The penis is pendent, and there appeared to be two suspensory ligaments. The gland is surrounded by a circular hump consisting of connective tissue, and apparently not connected in any way with the corpora cavernosa.

The author not having had the opportunity of dissecting a female *Galeopithecus* cannot give any account of the female generative apparatus, and must therefore limit himself to offering a *résumé* of the observations made by Leche upon that part of its economy. According to that author,¹⁹ there is nothing especially noticeable about the ovaries, except that they are enclosed like the hedgehog in wide-mouth peritoneal sacs, their diaphragmatic ligament extending to the posterior surface of the diaphragm. The uterus, however, is bifid, and the two uteri open by distinct openings into the vagina, in which respect *Galeopithecus* agrees with Chiroptera and differs from Insectivora. Among the latter it is said that in *Tupaia nana* there is a slight indication of a double uterus. The external generative organs resemble, however, those of the lemurs,

¹⁹ *Op. cit.*, p. 68.

the clitoris being concealed by a circular fold of integument, as obtains also in *Chiromys*.²⁰ The teats are pectoral in position, and there are two pairs. One young only is born at birth, as obtains also in Chiroptera. The placenta is said by Gervais²¹ to be discoid. If such is the case, then *Galeopithecus* agrees in the character of its placentation with the Chiroptera and Insectivora, and not with the Lemuroidea, the placenta in the latter (*Propithecus diadema*, *Lemur rufipes*) being diffuse.²²

From the above observations it appears that *Galeopithecus* agrees as regards its organization in some respects with the Lemuroidea, in others with the Insectivora and in others with the Chiroptera, and yet again differing in many respects from all three.²³ Considerable difference of opinion has, therefore, prevailed in the past and still prevails among systematists as to which of these three orders of mammals *Galeopithecus* should be referred to, or whether it should be regarded as the sole representative of a fourth distinct order of mammals, Galeopithecidae. The species of *Galeopithecus* upon the study of which this communication was based was called by Linnæus²⁴ *Lemur volans*, a name indicating perfectly the view of the great naturalist as to its natural affinities. Pallas,²⁵ who was among the first to describe *Galeopithecus*, while admitting that it resembled in some respects the Lemuroidea, considered it as being equally closely related to the Chiroptera. To the latter order of mammals it was referred by Cuvier.²⁶ In modern times *Galeopithecus* has been usually regarded as being an aberrant form of Insectivora, that view being held more particularly by the English anatomists, such as Huxley,²⁷ Flower and Lydeker.²⁸ Notwithstanding the difference of opinion as to the nature of *Galeopithecus* held by the above anatomists and others, all agree

²⁰ H. C. Chapman, *Proc. Acad. Nat. Sciences*, 1900, p. 423.

²¹ *Op. cit.*, p. 448.

²² Wm. Turner, *Comparative Anatomy of the Placenta*, 1876, p. 57; A. Milne-Edwards et Grandidier, *Madagascar Mammifères*, T. 1, 1875, p. 282.

²³ For a résumé of these agreements and disagreements, see Leche, *op. cit.*, pp. 72-74.

²⁴ *Systema Naturæ*, 1758, Tomus 1, p. 30.

²⁵ *Galeopithecus Volans Camellii Descriptus*, Acta Acad. Scient. Imperialis Petropolitanae, 1780, p. 208.

²⁶ *Règne Animal*, 1817, Tome I, p. 80.

²⁷ *Anatomy of Vertebrated Animals*, 1872, p. 383.

²⁸ *Mammals Living and Extinct*, 1891, p. 615.

that while *Galeopithecus* may resemble or differ from Lemuroidea, Rodentia, Insectivora or Chiroptera, nevertheless it presents so many peculiarities in its organization that it stands by itself. No one doubts that a *Petauris* is a marsupial, a *Pteromys* a rodent, a *Propithecus* a lemur, a *Pteropus* a bat, even though they all are provided with a patagium resembling more or less that of *Galeopithecus*, by means of which they fly or dart through the air. *Galeopithecus*, however, stands alone; it is *sui generis*. To no order can it be referred unless to some hypothetical extinct one, fossil remains of which have not yet been discovered. The most plausible view as yet advanced as to the affinities of *Galeopithecus* with the mammals with which it has been usually associated is to suppose with Leche²⁹ that there once existed, in remote Mesozoic times, an order of mammals of ungulate character from which have descended *Galeopithecus*, the Chiroptera, Lemuroidea and Insectivora. Certain facts otherwise difficult to explain become then intelligible. For example, if the lemurs of the present day have descended from Eocene lemurs like *Adapis*, *Anaptomorphoris*, *Tomitherum*, *Hyopsodus*, *Notharctus*,³⁰ generalized forms combining ungulate with quadrumanous characters, certain peculiarities of their alimentary canal and their non-deciduous diffuse placenta may be explained as being due to inheritance from remote ungulate ancestors. Further, the fact that the condyle of the jaw is situated nearly on a line with the teeth in *Galeopithecus*, *Chiromys*, in certain Insectivora and Chiroptera, as in the *Diplocynodon* and kindred mammals, the *Pantotheria* of Jurassic times³¹ points to the same conclusion. Accepting the above hypotheses as provisionally correct, it follows that the herbivorous character of the alimentary canal of *Galeopithecus* is due to inheritance from an ungulate ancestor, whereas its patagium has been acquired in some unknown way through adaptation. Were it not for the combination of the above characters, *Galeopithecus* would have become long since extinct in the struggle for life with its contemporaries, the lemurs, insectivores and bats.

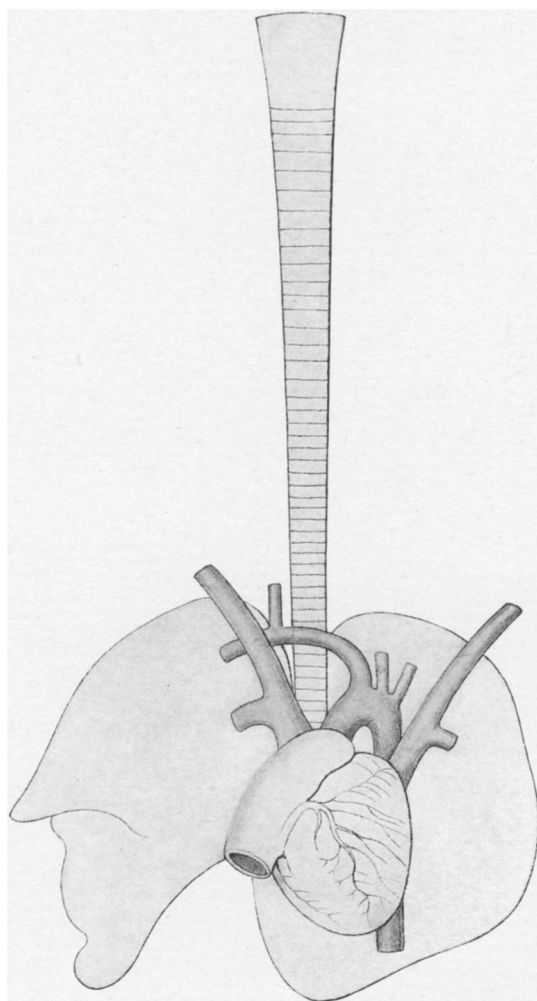
It appears, at least in the judgment of the author, that *Galeopi-*

²⁹ *Op. cit.*, p. 78.

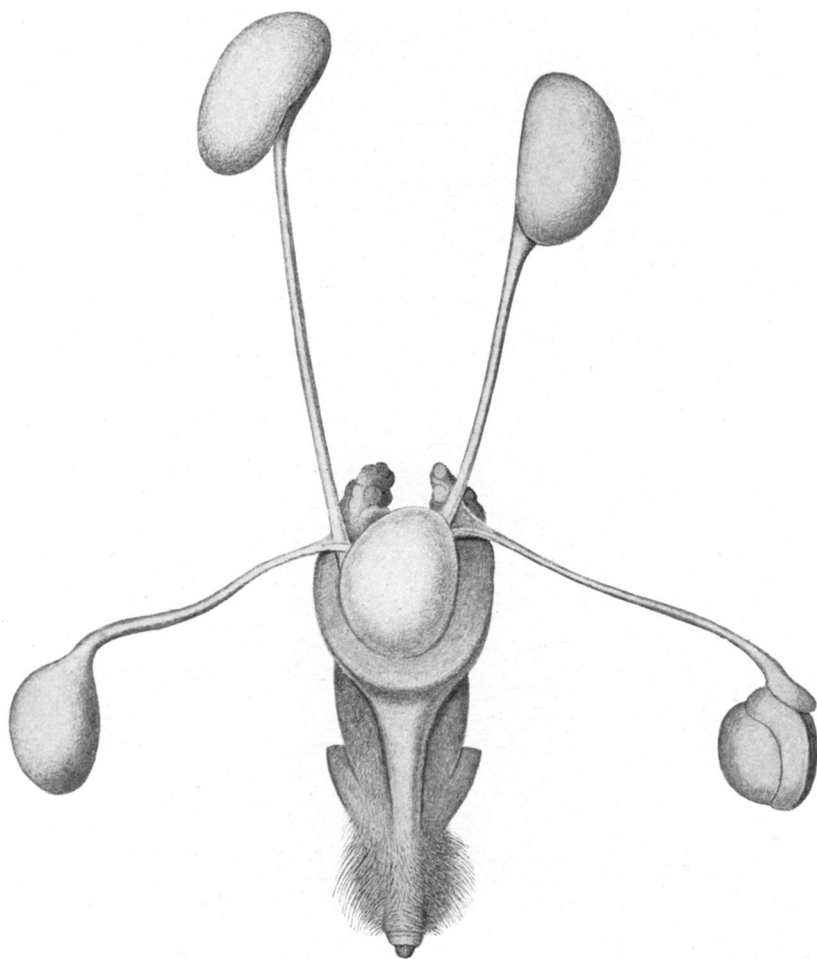
³⁰ Cuvier, *Ossements Fossiles*, 1835, T. 5, p. 460; Leidy, *Report U. S. Geol. Survey*, 1873, pp. 75, 86; Cope, *U. S. Geol. Survey*, Vol. III, 1884, pp. 233-235.

³¹ Marsh, *Op. cit.*, p. 235.

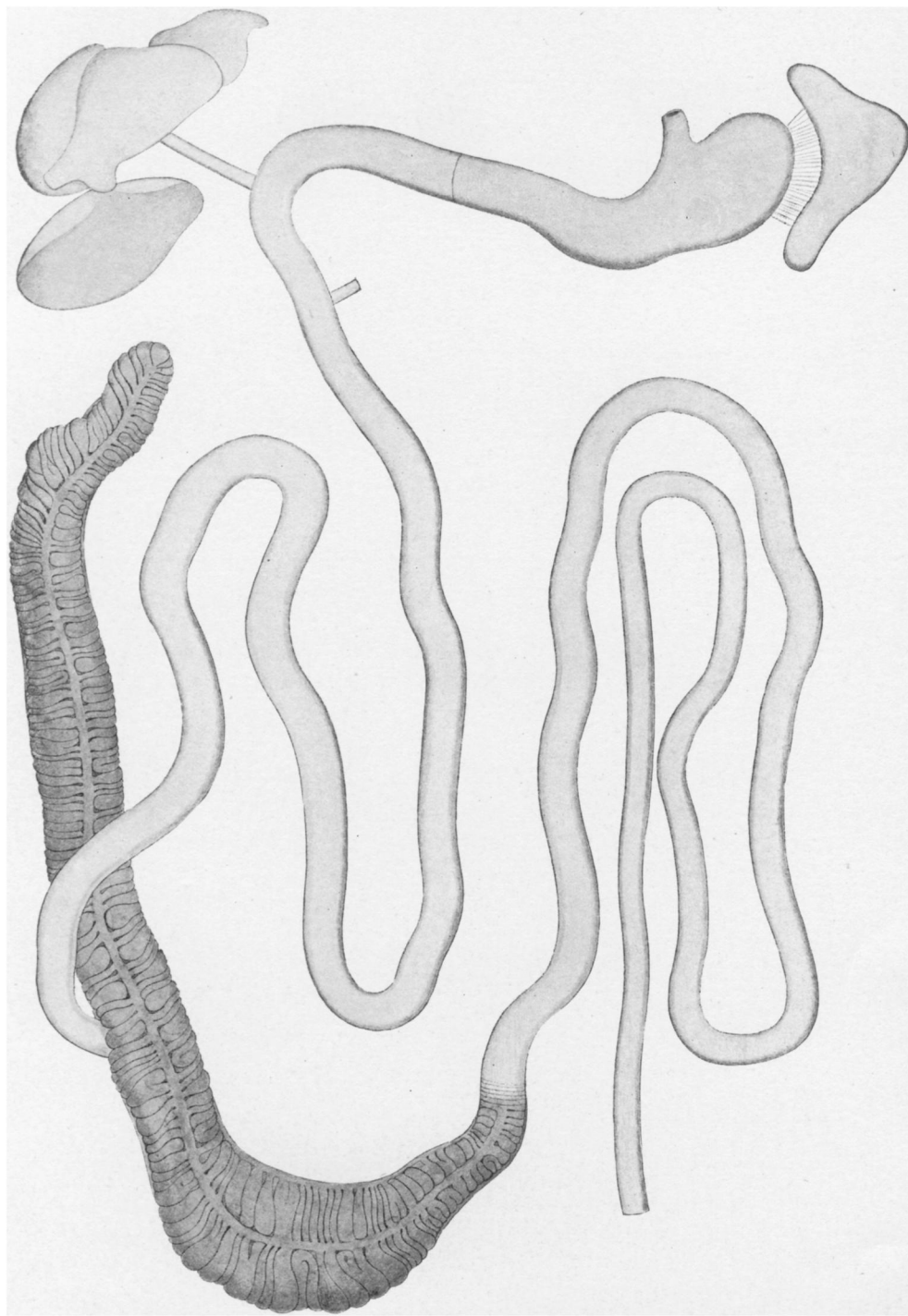
thecus cannot be regarded as being either a lemur, insectivore or bat, but that it stands alone, the sole representative of an ancient order, Galeopithecidæ, as *Hyrax* does of Hyracoidea. While *Galeopithecus* is but remotely related to the Lemuroidea and Insectivora, it is so closely related to Chiroptera, more particularly in regard to the structure of its patagium, brain, alimentary canal, genito-urinary apparatus, placenta, etc., that there can be but little doubt that the Chiroptera are the descendants of *Galeopithecus*, or more probably that both are the descendants of a *Galeopithecus*-like ancestor.



CHAPMAN ON GALEOPITHECUS.



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